International Research Journal of Applied and Basic Sciences
© 2013 Available online at www.irjabs.com
ISSN 2251-838X / Vol, 4 (3): 724-727
Science Explorer Publications

IRJABS

An overview of genetically modified food products: Benefits, risks, health safety and related regulations

Seyedeh-Maryam Hasheminya[1], Jalal Dehghannya[2,*]

1. Department of Food Science and Technology, Islamic Azad University, Science and Research Branch, Tehran, Iran
2 . Department of Food Science and Technology, Faculty of Agriculture, University of Tabriz, Tabriz, Iran
29 Bahman Blvd., 51666-16471, Tabriz, Iran

[*] ***Corresponding author email:*** J_dehghannya@tabrizu.ac.ir

ABSTRACT: Use of modern biotechnology to produce Genetically Modified (GM) food products is a way of providing food safety. One of the major causes of the products development is their high production compared to their traditional counterparts. However, there are many concerns about unpredictable and harmful effects of these foods. Introduction of genetically modified food products into environment without risk assessment and enough investigations by responsible organizations is not rational. In recent years, legal international organizations responsible for safety of foods and the environment have held conventions on assessment of possible risks of genetically modified foods. In this review, benefits, drawbacks and possible risks of GM food products, ethical and legal assessment and risk management of potential health hazards of the products in international level, safety management of production and research procedures as well as the status of setting and controlling regulations in Iran will be evaluated.

Keywords: Biosafety, Biotechnology, Health, Legal assessment, Risk management

INTRODUCTION

Increase in the world population has led to increasing need for food products. Meeting this need is a challenge confronted with many developing countries. Many efficient modern technologies have been developed to be used in food industries among which are modification of farming methods, use of modified varieties and modification of preserving methods of agricultural products. In this regard, use of genetically modified varieties through modern agricultural technologies such as biotechnology is a way of obtaining food safety (Falk et al., 2002; Rahnama, 2009).

Using biotechnology, researchers can produce genetically modified organisms (yeasts and bacteria) with appropriate characteristics. Important parts of biotechnology in agriculture are based on principles which include incubation of plant cells and tissues, use of recombinant DNA markers as well as genetic engineering. The two later include artificial transfer of genes or gene segments from one organism to another one in order to produce new desirable traits in receiver plant or animal. GM potato and bananas resistant to nematode are some important examples in sustainable agriculture (Garza and Stover, 2003).

Benefits, drawbacks and possible risks of GM food products

Today, biotechnology is a powerful means of scientific development in the fields of agricultural, pharmaceutical, environmental and food industries. Production of horticultural and farm plants showing high resistance to viruses, funguses, insects, pests and inappropriate environmental conditions such as salinity, frost, draught and heat stress has been possible. Also, GM products can be used for production of industrial and pharmaceutical compounds such as vaccines, antibodies, organic vitamins and amino acids. Further, biotechnology can be efficient in the fields of environment for producing different fuels such as methane, scavenging different pollutants from the environment and finding efficient species for better refinement of sewage and polluted soils (Uzogara, 2000).

Potential production of high quality foods in terms of aroma, taste and flavor, higher shelf life and nutritional value has been facilitated with the aid of modern biotechnology; thus it can be regarded as a large step in meeting food safety in developing countries. Modern biotechnology can be used to alleviate malnutrition due to

lack of micronutrients as well as to improve health condition of the said communities. For example, since rice is the major food product consumed in many parts of Southeast Asia and annually 250,000 children become blind due to lack of vitamin A in rice, researches have produced rice products containing vitamin A using biotechnology (Paine et al., 2005).

Possible risks of GM food products

Although GM food products have many benefits, health experts often alarm consumers on possible risks of the foodstuffs. They have many concerns about allergenicity, toxicity and carcinogenesis properties of GM products and believe that sometimes transforming new genetic substances to target cells may not be successful and therefore, the change in performance of different genes can lead to unexpected genetic mutations. In other words, new genes introduced into agricultural products may result in allergenicity through production of new proteins as well as in enhanced toxicity of plants through induction of metabolic changes in plants. Also, there are hypotheses on possibility of allergenicity by proteins produced through biotechnology such as GM proteins of groundnut, wheat, eggs, milk, kernels, fish, Shelli and crawfish for prone individuals (Young and Lewis, 1995; Nordlee et al., 1996; Sten et al., 2002; Selgrade et al., 2003; Celec et al., 2005; Devos et al., 2005; Lehrer and Bannon, 2005).

In addition, critics argue that GM crops resistant to different stresses result in the growth of super weeds in spite of crop yield enhancement. Herbicides can be used in order to alleviate this; however, they are harmful to environment since most herbicides and toxins not only destroy natural life cycle of useful insects but also they have undesirable effects on biological diversity by introducing certain traits into GM crops. Moreover, it is said that as a result of farmer's tendency to plant these new products, planting other products is gradually being omitted from agricultural systems; thus endangering natural cycle of the environment. On the other hand, GM seeds produced by large and powerful multinational companies are designed such that they can be used just for the first planting and this problem has led to strong dependency of farmers on the productive seeds. This injustice in modern agriculture is a threat to sustainable development of the developing countries which import the said seeds. Other disadvantages of productive seeds applications are reduced food safety for women and children and endangered living of farmers in developing countries (Cavan et al., 1998; Richards et al., 2003; Madsen and Sandoo, 2005; Shrader, 2005; Februhartanty et al., 2007).

Ethical and legal assessment and risk management of potential health hazards of GM products in international level

Although use of biotechnology has been efficient for food production, there are many questions concerning ethics, legality, biosafety, health care, merchandising, social and cultural issues of GM food consumption. Use of biotechnology has caused great promotions in science and made it possible to produce plants of new genetic traits. However, lack of information about consequences of the changes created in GM products is a threatening issue (Costa et al., 2008). Therefore, in order to determine legal limits and prevent from undesirable consequences, a definition of ethics and observance of ethical limits when using this technology seems necessary. Ethics in GM technology is defined as a collection of guidelines which evaluate permitted limits of genetic experiments applicable on live organisms from the ethical point of view. In other words, ethics in GM technology is a practical strategy for enhancement of benefits and reduction of risks in genomic technologies (Van Raamsdonk, 2000; Mohajer et al., 2011).

Of ethical areas studied, we can refer to risk management when producing and consuming GM products, collaboration with legal issues of other international organizations, information exchange among society experts, obtaining a patent on GM invention and ownership of gene sequence as well as harmful effects of the said products on human beings, environment and biodiversity (Mohajer et al., 2011).

Regarding the importance of GM-related developments as well as genetic engineering in all aspects and potential risks resulted from ignorance of biosafety principles, special conferences on GM products have been held by legal organizations including WHO, FAO and Codex Alimentarius Commission. The Codex Alimentarius Commission established by FAO has been responsible for executing food standards set by FAO and WHO since 1962. Possible risks of GM organisms first assessed at Asilomar conference in 1975 followed by approving the first legal regulation of GM products in 1990 decade. Also, international treaty of biodiversity was signed in Rio de Janeiro in 1992 and executed in 1993. This treaty is a driving force for ratification of Cartagena protocol which is regarded as an attachment to biodiversity treaty. Cartagena protocol is a major international tool for controlling transportation of GM products and is executable worldwide. Ratification of this protocol is an important step in creation of a unified framework for regulating standards of risk management with regard to necessity of extending universal trade for GM technology.

It is clear that to obtain a united control over international trade of GM products, there should be a comprehensive criterion on safety assessment of the products. In order to obtain this purpose, organizations such as FAO, WHO and Codex Alimentarius Commission have held specialized conferences on safety assessment of GM products. This commission along with common committees of FAO and WHO presented

particular definitions for GM products in 1995 and held conferences on possible risks of GM foods and their assessment before introducing and after supplying into market. In addition, the said organizations attempted to set special guidelines for risk management and to consider long effects of these foods on consumer's health such as allergenicity effects (Hashemi and Shoja Sadati, 2010). Another issue discussed by experts of Codex Alimentarius Commission is GM foods labeling. The right to know, choose, compensate and learn about newly introduced products as well as to be aware of ingredients and properties of these products is of consumer's rights. Most countries producing GM products are bound to label their products as "Genetically Modified" in accordance with universal standards. However, some countries do not label some necessary information which leads to consumers' dissatisfaction (Hoef et al., 1998; Raab and Grobe, 2003; Smyth and Phillips, 2003; Sotgiu et al., 2005; Kazemi and Abbasi, 2009; Paparini and Romano-Spica, 2009).

Regarding risk assessment of GM foods, it should be mentioned that measurements related to safety verification of these products have been based on the concept of "substantial equivalence". This concept developed by OECD (The Organization for Economic Cooperation and Development) and modified by WHO is a comparison process which compares GM products with their traditional counterparts. This comparison is performed with the use of special assays of Codex Alimentarius Commission by measuring protein allergenicity, product toxicity and other assessments (Niga et al., 2004; Lemaux, 2008; Mazaheri Assadi and Khani Jazani, 2009).

Safety management of production and research procedures of GM products

Many GM products are produced under tightly controlled laboratory conditions. However, some of these products which are produced for use in outside conditions require more attention to minimize their undesirable effects on the environment. An important method for safety management of GM products is based on monitoring the genetic modification process of live organisms, commonly used in Australia and EU (Hashemi and Shoja Sadati, 2010).

According to management standards of the genetic modification process in Europe, preliminary experiments on GM products are performed in tight laboratory conditions under different biosafety levels. In order to control possible risks of GM products, presence of safety committee is necessary. During biosafety level assessment of GM products by related committee, all new properties, effects and environmental interactions including the products' phenotype changes and their effects on human health are evaluated. Of among important issues investigated by safety committee is the occurrence of new unwanted mechanisms leading to formation of unexpected properties in GM products such as horizontal gene transfer, genetic mutations and selective transcription. In horizontal gene transfer, gene of a GM organism may be transferred to other members of the same or other species. For instance, gene of a GM plant producing toxin can be transferred to another plants consumed by human through pollination. It should be noted that this gene transfer and their negative effects on human health may be hidden for years and ultimately affect the society (Houghton et al., 2008).

In addition to monitor procedures of studies performed by researchers and expert in laboratories or related institutes, committee of biosafety records reports on unpredictable events, proposes useful strategies to inhibit their recurrence and designs urgent reactions to extinct high risk GM organisms. After conducting experiments in laboratories, field experiments are performed. At first, field experiments are carried out in small scale followed by large scale experiments. All procedures of the experiments whether in laboratory or in field are monitored by several organizations. All organizations involved are appointed by government and parliaments of the nations (Houghton et al., 2008).

The status of setting and controlling regulations of GM products in Iran

Various economic and trade exchanges take place between countries including Iran. Therefore, development of national biosafety requirements by respected authorities is necessary. These requirements guarantee that possible risks of GM products for human and the environment will be minimized. In this regard, government of Islamic republic of Iran has declared his obligation to observe biosafety standard through joining the biodiversity convention. In addition to define the structure of national biosafety committee, national biosafety act of Iran includes rules and regulations of GM products production and trade. Development of control unit and appointment of decision makers and respected executing bodies involved in the affairs of GM products are under the control of the national biosafety act. Also, issuance of license for applicants is included in the said act. According to the national biosafety act of Islamic republic of Iran, assessment of GM products safety is issued by the Ministry of Health and Medical Education. Cure and medical instruction and assessment of bioenvironmental risks of GM products are performed by Iran Department of Environment. Ministry of Agriculture is served as the national biosafety act authority (Hasheminya, 2012).

CONCLUSION

Although genetically modified food products are regarded as one of the important scientific achievements of human beings, use of this technology by uninformed and inexperienced publics may endanger human health

and the environment. In other words, introduction of these products into the environment without risk assessment and enough investigations by responsible organizations is not rational. Thus, in order to enjoy benefits of the technology, a collection of rules and regulations called biosafety act has been adopted by national and international authorities. These regulations are aimed at reducing possible risks of GM products.

REFERENCES

Cavan G, Biss P, Moss SR. 1998. Herbicide resistance and gene flow in wild-oats (Avena fatua and Avena sterilis ssp. ludoviciana). Ann Appl Biol. 133(2): 207–17.

Celec P, Kukučková M, Renczésová V, Natarajan S, Pálffy R, Gardlík R. 2005. Biological and biomedical aspects of genetically modified food. Biomed Pharmacother. 59(10): 531–40.

Costa Font M, Gil JM, Traill WB. 2008. Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy. Food Policy. 33(2): 99–111.

Devos Y, Reheul D, De Schrijver A. 2005. The co-existence between transgenic and nontransgenic maize in the European Union: a focus on pollen flow and cross-fertilization. Environ Biosafety Res. 4 (2): 71–87.

Falk MC, Chassy BM, Harlander SK, Hoban TJ, McGloughlin MN, Akhlaghi AR. 2002. Food biotechnology: Benefits and concerns. Am Soc Nutr Sci. 132(6): 1384–90.

Februhartanty J, Widyastuti TN, Iswarawanti DN. 2007. Attitudes of agricultural scientists in Indonesia towards genetically modified foods. Asia Pac J Clin Nutr. 16(2): 375–80.

Garza C, Stover P. 2003. Genetically modified foods for human health and nutrition: The scientific basis for benefit/risk assessment. Trends Food Sci Tech. 14(5): 182–90.

Hashemi M, Shoja Sadati A. 2010. Genetically-modified food: Opportunities & challenges. J Food Sci Tech. 7(1): 89–102. (in Persian).

Hasheminya SM. 2012. Management mechanisms in food biotechnology (in Persian). 2nd National & 1st International MBA-Biotechnology Congress, Dec 10–11, Tehran University of Medical Sciences, Tehran, Iran.

Hoef AM, Kok EJ, Bowo E, Kuiper HA, Keijer J. 1998. Development and application of a selective detection method for genetically modified soy and soy derived products. Food Add Contamin. 15(7): 767–74.

Houghton JR, Rowe G, Frewer LJ, Van Kleef E, Chryssochoidis G, Kehagia O. et al. 2008. The quality of food risk management in Europe: Perspectives and priorities. Food Policy. 33(1):13–26.

Kazemi A, Abbasi M. 2009. Genetically Modified Foods and Consumers Rights. Ethics Sci Tech. 3(3-4): 47–55. (in Persian).

Lehrer SB, Bannon GA. 2005. Risks of allergic reactions to biotech proteins in foods: Perception and reality. Allergy. 60(5): 559–64.

Lemaux PG. 2008. Genetically engineered plants and foods: A scientist's analysis of the issues (Part I). Annu Rev Plant Biol. 59:771–812.

Madsen KH, Sandoo P. 2005. Ethical reflection on herbicide-resistant crops. Pest Manag Sci. 61(3): 18–25.

Mazaheri Assadi M, Khani Jazani J. 2009. Bioethics and Biosafety in Biotechnology. Ethics Sci Tech. 3(3-4): 71–6. (in Persian).

Mohajer M, Safaei H, Mahdavi Damghani A. 2011. Ethical and legal considerations for application of transgenic products: a critical review of national Iranian biosafety law. Ethics Sci Tech. 6(1):35–42. (in Persian).

Niga K, Cockburnb A, Crevelc RWR, Debruyned E, Grafstroeme R, Hammerlingf U. et al. 2004. Assessment of the safety of foods derived from genetically modified (GM) crops. Food Chem Toxicol. 42(7): 1047–88.

Nordlee JA, Taylor SL, Townsend JA, Thomas LA, Bush RK. 1996. Identification of Brazil nut allergen in transgenic soybeans. N Engl J Med. 334: 668–92.

Paine JA, Shipton CA, Chaggar S, Howells RM, Kennedy MJ. 2005. Improving the nutritional value of Golden Rice through increased provitamin A content. Nat Biotechnol. 23(4): 429–30.

Paparini A, Romano-Spica V. 2004. Public health issues related with the consumption of food obtained from genetically modified organisms. Biotechnol Annu Rev. 10: 85–122.

Raab C, Grobe D. 2003. Labeling genetically engineered food: The consumer right to know? AgBioForum. 6(4): 155–61.

Rahnama H. 2009. Bioethics and Transgenic Crops Production. Ethics Sci Tech. 3(1–2): 1–14. (in Persian).

Richards HA, Han CT, Hopkins RG, Failla ML, Ward WW, Stewart CN. 2003. Safety assessment of recombinant green fluorescent protein orally administered to weaned rats. J NUTR. 133(6): 1909–12.

Selgrade MK, Kimber I, Goldman L, Germolec DR. 2003. Assessment of allergenic potential of genetically modified foods: an agenda for future research. Environ Health Perspect. 111(8): 1140–41.

Shrader FK. 2005. Property rights and genetic engineering: Developing nations at risk. Sci Eng Ethiics. 11(1): 137–49.

Smyth S, Phillips PW. 2003. Labeling to manage marketing of GM foods. Trends Biotechnol. 21(9): 389–93.

Sotgiu A, Tala M, Sardu G, Coroneo V, Dessi S, Contu P. 2005. Genetically modified organisms: Uropean and Italian legislation to protect citizens' health. Ig Sanita Pubbl. 61(5): 475–96.

Sten E, Stahl Skov P, Andersen SB. 2002. Allergenic components of a novel food, Micronesian nut Nangai, shows IgE cross reactivity in pollen allergic patients. Allergy. 57(5): 398–404.

Uzogara SG. 2000. The impact of genetic modification of human foods in the 21st century: A review. Biotechnol Adv. 18(3): 179–206.

Van Raamsdonk LWD. 2000. Biological aspects and ethical considerations for the Utilization of GMOs. Dev Plant Genetics Breeding. 5: 262–69.

Young AL, Lewis CG. 1995. Biotechnology and potential nutritional implications for children. Pediatr Clin N Am. 42(4): 917–30.